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IS 11597 (1986): Polyester tape wrapped, varnish bonded glass-fibre covered rectangular paper conductors [ETD 33: Winding Wire]



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Indian Standard

**SPECIFICATION FOR
POLYESTER TAPE WRAPPED, VARNISH
BONDED GLASS-FIBRE COVERED
RECTANGULAR COPPER CONDUCTORS**

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR POLYESTER TAPE WRAPPED, VARNISH BONDED GLASS-FIBRE COVERED RECTANGULAR COPPER CONDUCTORS

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Indian Standard

SPECIFICATION FOR POLYESTER TAPE WRAPPED, VARNISH BONDED GLASS-FIBRE COVERED RECTANGULAR COPPER CONDUCTORS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 February 1986, after the draft finalized by the Winding Wires Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard covers the requirements and test methods of polyester tape wrapped, varnish bonded glass-fibre covered rectangular copper conductors.

0.3 In the preparation of this standard, assistance has been derived from ASTM D 3664-1978 'Standard specification for biaxially oriented polyethylene terephthalate film for electrical insulation and dielectric application', issued by the American Society for Testing and Materials.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard relates to rectangular copper conductors which are first wrapped by polyester tape (without any adhesive) in required thickness and subsequently covered with fibre glass and finally bonded with suitable thermosetting varnish depending on required temperature index of the conductor as required by the purchaser.

NOTE — Individual temperature indices and generic name of varnishes may be agreed between the manufacturer and the purchaser.

*Rules for rounding off numerical values (*revised*).

1.2 Sizes — The requirements of this standard are applicable to rectangular conductors having thickness from 0.80 mm up to and including 5.60 mm and width from 2.0 mm up to and including 16.0 mm. A schedule of preferred sizes of rectangular conductors is given in IS : 6160-1971*.

1.3 This standard relates to conductor in application with temperature indices of 130° and 155°C.

1.4 Type of Covering — The types of covering are specified depending on single or double layer or multilayer of polyester wrapping followed by glass fibre covering as per requirements.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Conductor — The bare metal after removal of the covering.

2.2 Increase in Dimensions Due to Covering — The difference between the measurement over the total covering on the minor axis and the corresponding dimensions of the conductor.

2.3 Tolerance — The permissible divergence of an actual magnitude from that of prescribed.

3. GENERAL TEST CONDITIONS

3.1 Unless otherwise specified all tests shall be carried out within a temperature range of 15 to 35°C, and at a relative humidity range of 45 to 75 percent. Before measurements are made, the specimens shall be preconditioned under these atmospheric conditions for a time sufficient to allow specimens to reach stability.

3.2 The wire to be tested shall be removed from the packaging in such a way that the wire will not be subjected to tension or unnecessary bends.

3.3 Before each test, sufficient wire shall be discarded to ensure that any damaged wire is not included in the test specimen.

3.4 When no specific range of sizes is given for a test, the test is applicable to all sizes.

4. CONDUCTOR

4.1 The conductor shall fully conform to **3.1** of IS : 6160-1971*.

*Specification for rectangular conductors for electrical machines.

5. COVERING

5.1 Polyester Tape — The tape of nominal thickness (0.02 mm) shall be wrapped on the conductor.

Maximum width of the tape should not be more than $1.5 \times (\text{width} + \text{thickness})$ of conductor.

NOTE — Because of various factors like dielectric strength, consolidation and compactness, etc, this is a recommended thickness.

Polyester tape of suitable width shall be taken by the manufacturer subject to maximum width of the tape of $1.5 \times (\text{width} + \text{thickness})$ of the conductor. For this, polyester tape rolls of suitable width can be slitted out of a roll of polyester film of desired thickness and it shall be ensured that the same are uniformly slitted and free from burrs and uneven cuttings.

5.2 Glass Fibre — Suitable quality of glass-fibre may be taken as per requirements for fine, medium and thick covering. The requirements for electrical grade glass-fibre shall meet those given in IS : 4685 (Part 2)-1984*.

5.3 Application of Covering

5.3.0 General — Before covering, the conductor shall be completely free from surface defects like burrs and copper dust, etc.

5.3.1 Polyester Tape Covering — Either one or two layers of polyester tape of nominal thickness (0.02 mm) shall be wrapped on the conductor with half overlapping. The types of polyester coverings are to be taken as per the requirements. The tape shall be wrapped on the conductor tightly, evenly and free from creases and wrinkles so that the covering adheres firmly when double layers are applied. The arrangement of layers shall be as agreed between the purchaser and the supplier. The increase in dimensions due to polyester tape covering shall be as given in Table 1 and the requirements of polyester tape shall conform to those given in Table 2.

TABLE 1 INCREASE IN DIMENSIONS DUE TO POLYESTER TAPE COVERING

TYPE OF COVERING	INCREASE IN DIMENSIONS DUE TO COVERING mm
(1)	(2)
Type I	0.07, <i>Min</i> 0.09, <i>Max</i>
Type II	0.14, <i>Min</i> 0.18, <i>Max</i>

Type I -- Single tape covering of polyester tape.

Type II -- Double or multilayer tape covering of polyester tape.

NOTE — The thickness of polyester tape shall be taken as 0.02 mm unless otherwise specified. This may be applied to all conductors of specified dimensions.

*Specification for varnish bonded glass-fibre covered copper conductors: Part 2 Rectangular conductors (*first revision*).

TABLE 2 REQUIREMENTS OF POLYESTER TAPE

(Clause 5.3.1)

Sl. No.	PROPERTIES	REQUIREMENTS	REMARKS
(1)	(2)	(3)	(4)
1.	Thickness, μm	24.6 ± 2.8 4.3	Tolerance given is for 1 mil thickness. It will proportionally vary with thickness
2.	Density, g/cc	1.388 - 1.410	
3.	Shrinkage at 150°C, % <i>Max</i>	4.0	
4.	Moisture absorption, % <i>Max</i>	0.6	
5.	Tensile strength, MD & TD kgf/cm ² , <i>Min</i>	1 380	
6.	Elongation at break, MD & TD %, <i>Min</i>	70.0	
7.	Modulus of elasticity, MD & TD kgf/cm ²	45 000	Recommended values
8.	Bursting strength kgf/ cm ² , <i>Min</i>	4.75	
9.	Tear strength (Elmendroff) g, <i>Min</i>	211	
10.	Fold endurance, cycles, <i>Min</i>	1 400	
11.	Oxygen index	20-25	
12.	Melting point °C, <i>Min</i>	150	
13.	Dielectric strength, volts/mil, <i>Min</i>	5 000	
14.	Volume resistivity, chm-cm, <i>Min</i> (at 23°C, 50 % RH)	10^{16}	
15.	Surface resistivity at 80% RH, ohm.cm	10^{12}	
16.	Permittivity	3.2 ± 0.1	Recommended values
17.	Dissipation factor, <i>Min</i>	0.004	
18.	Thermal class	B	

5.3.2 Glass Covering — Polyester tape covered conductors shall be covered with two layers of glass-fibre applied firmly, evenly, closely and continuously and in the opposite direction. The glass-fibre covering in all cases shall be firmly bonded with suitable type of thermosetting varnish as per temperature index. The increase in dimensions due to fibre glass covering and varnishing over polyester wrapped conductor shall be as given in Table 3.

NOTE 1 — Unless otherwise specified, all tests including dimensional requirement shall be carried out as given in IS : 4685 (Part 2)-1984*.

*Specification for varnish bonded glass fibre covered copper conductors: Part 2 Rectangular conductors (*first revision*).

NOTE 2 — The maximum dimensions due to individual coverings may be exceeded provided that the overall dimensions of the insulated conductor remain within the maximum permitted dimensions of the bare conductor plus the maximum increase due to the combined covering obtained by adding individual maximum values of polyester tape and glass-fibre covering at stipulated in Table 3.

TABLE 3 INCREASE IN DIMENSIONS DUE TO GLASS COVERING AND OVERALL DIMENSIONS OF THE CONDUCTOR

(Clause 5.3.2)

BARE CONDUCTOR WIDTH, mm	INCREASE IN THICK- NESS DUE TO GLASS WRAPPING			OVERALL THICKNESS WITH POLYESTER TAPE AND FIBRE GLASS COVERING AND VARNISH						
	—	5·6	10·0	—		5·6		10·0		
	5·6	10·0	16·0	5·6		10·0		16·0		
	Type I		Type II		Type I		Type II		Type I	
Up to and In- cluding	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Increase in thick- ness/overall thickness	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Fine, <i>Min</i>	0·16	0·18	0·20	0·23	0·30	0·25	0·34	0·27	0·34	
<i>Max</i>	0·23	0·25	0·28	0·34	0·41	0·34	0·43	0·37	0·46	
Medium, <i>Min</i>	0·23	0·23	0·28	0·30	0·37	0·30	0·37	0·35	0·42	
<i>Max</i>	0·33	0·33	0·35	0·42	0·51	0·42	0·51	0·44	0·53	
Thick, <i>Min</i>	0·35	0·35	0·35	0·42	0·49	0·42	0·49	0·42	0·49	
<i>Max</i>	0·43	0·43	0·43	0·52	0·61	0·52	0·61	0·52	0·61	

6. FLEXIBILITY AND ADHERENCE

6.1 Flexibility

6.1.1 As Received — Sample of covered conductors shall be bent through 180° round a polished metal mandrel having a diameter 10 times the thickness of the conductor when it is bent on edge or flat or both. Separate samples shall be bent, two on edge and two on flat. When so tested, the fibre glass coverings shall not open sufficiently to expose the conductor to view, when examined under diffused light by normal eyesight. There shall be no appreciable loosening of the insulation.

6.1.2 After Heat Ageing — Under consideration.

6.2 Cure Test — Two samples approximately 200 mm long, shall be laid flat to flat and covered with polyester tape and then placed in hot air circulating oven at 160°C for 45 minutes in case of the material of temperature index 130 and at 180°C for 45 minutes in case of material

of temperature index 155. Samples shall then be removed from the oven and cooled to room temperature. After removal of the binding tape, it shall be possible to separate the conductors without damaging the covering.

6.3 Breakdown Voltage — The conductor shall meet the requirements of 6.3.1 and 6.3.2 when tested at room temperature and at elevated temperature respectively.

6.3.1 Test at Room Temperature — Samples shall be subjected to a breakdown voltage test by the method described in Appendix A. Five tests shall be made. Four out of the five tests shall meet the requirements given in Table 4 and fifth test shall meet at least 50 percent of the required value.

6.3.2 Test at Elevated Temperature — When tested by the method described in Appendix A at the rated temperature, at least four out of the five specimens tested shall not break down at voltages less than those specified in Table 4. The fifth value shall meet at least 50 percent of the required value.

TABLE 4 BREAKDOWN VOLTAGE OF POLYESTER TAPE WRAPPED GLASS-FIBRE COVERED CONDUCTORS

(Clauses 6.3.1 and 6.3.2)

TYPE OF COVERING	MINIMUM BREAKDOWN VOLTAGE IN VOLTS (rms)			
	At Room Temperature		At Elevated Temperature	
	Type I	Type II	Type I	Type II
	(2)	(3)	(4)	(5)
(1)				
Fine } Medium } Thick }	5 000	7 000	4 000	5 000

7. PACKING AND MARKING

7.1 The covered conductor shall be wound on drums, packed, wrapped and labelled in accordance with IS : 2069-1981*.

7.1.1 The conductor shall be protected against possible damage from the inner faces of the flanges of the drums by lining each flange with thick paper or plastic sheet. The material should be wrapped with smooth paper or suitable packing and one layer of corrugated paper shall cover it for protection.

*Specification for drums for covered winding wires and strips for electrical purposes (first revision).

7.2 The label which is to be securely attached to the drum shall have the following information. Alternatively, instead of using the label, the following information may be stencilled on the flanges of the drum:

- a) Manufacturer's name or trade-mark;
- b) Type of insulation covering;
- c) Conductor dimensions, bare as well as covered;
- d) Date of manufacture and supply;
- e) Drum No., lot No., Batch No.;
- f) Net weight of the material in the drum; and
- g) Tare weight of the drum.

7.2.1 The conductors may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

APPENDIX A

(*Clauses 6.3.1 and 6.3.2*)

BREAKDOWN VOLTAGE

A-1. TEST VOLTAGE

A-1.1 The test voltage shall be alternating and of a nominal frequency of 50 Hz and approximately sinusoidal, the peak factor being within the limits of $\sqrt{2} \pm 5$ percent 1.34 to (1.48). The test transformer should have a rating of at least 500 VA and should provide a current of essentially undisturbed wave form under test conditions.

A-1.2 The voltage is applied, starting from zero volts and increased at a uniform rate of rise of voltage 500 V/seconds until breakdown occurs. In the event of breakdown occurring in less than 5 seconds, the rate of increase is reduced to ensure that breakdown does not occur in less than 5 seconds.

A-2. TEST AT ROOM TEMPERATURE

A-2.1 A specimen of conductor 350 mm long shall have the insulation removed at one end and bent flatwise around a mandrel having the diameter of 50 mm for conductors with thicknesses up to and including 2.5 mm and 100 mm for conductors with thickness over 2.5 mm.

A-2.2 The specimen shall then be immersed in a metal container approximately 80 mm wide and 120 mm high and filled into a depth of 95 mm with nickel shots, nickel-plated shots or rust free steel ball bearings, 2.0 mm to 3.0 mm diameter, maintained in a clean condition by washing them, for example, in trichloroethylene.

A-2.3 The test voltage shall be applied between the conductor and the container.

A-3. TEST AT ELEVATED TEMPERATURE

A-3.1 Specimen prepared as described in **A-2-1** and the metal container to be used for test along with metal shots as described in **A-2.2** shall be pre-heated to the required temperature separately in an air-circulated oven.

A-3.2 After 15 minutes of heating, the specimen shall be inserted in the metal shots and voltage shall then be applied between the conductor and the container.

A-3.3 The test shall be completed within 30 minutes after placing the specimen in the oven.